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REMARKS

The present invention is directed to the discovery that the formation of deposits on the fuel injectors used in gasoline direct injector engines is controlled by combusting in the direct injector engines a gasoline fuel containing from about 12 to about 65 vol% aromatics wherein the source of the aromatics is a stream selected from the group consisting of reformat, a fluid cat cracker stream and mixtures of reformat and a fluid cat cracker stream, wherein, with respect to the fluid cat cracker stream a light fluid cat cracker stream constitutes about 70% to 100% of the fluid cat cracker stream.

In the present invention it must be initially recognized that the direct injectors in a gasoline direct injector engine are not the conventional port fuel injectors of conventional fuel injection system. Conventional port fuel injectors of the type referred to in the references cited by the Examiner do not directly inject gasoline into the combustion chamber, rather the injector tip is outside the combustion chamber and directs a spray of gasoline either toward the intake valve (outside the chamber) or into an air charge mixing chamber even further upstream of the intake valve. The injector in such a system is not and is never in the combustion chamber and is not exposed to the extreme environment of temperature and pressure present in the combustion chamber.

By comparison the injector in a gasoline direct injector system sprays gasoline directly into the combustion chamber. The injector tip is not located outside the chamber but rather is in the cylinder head itself and sprays gasoline directly into the combustion chamber. It is present in the combustion chamber much like the tip of the spark plug is in the combustion chamber.

The Examiner rejected claims 1-9 under 35 U.S.C. § 112, first paragraph as failing to comply with the written description requirement.

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In response to this rejection the claims have been redrafted to bring them back into conformity with the language and teaching of the specification.

Claims 1 and 4 as amended on March 11, 2003 recited that the source of aromatics comprises a fluid cat cracker stream, which is open ended language in that "comprising" is broader than the "consisting of" language appearing in the specification.

Claims 1 and 4 have been amended herein to bring them back into conformity with the language and teachings of the specification.

Claims 7-9 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter applicants regard as the invention.

Claims 7-9 as amended on March 11, 2003 recite that the aromatic source comprises a mixture of reformate and fluid cat cracker stream yet are in conflict with claims 1 and 4 upon which they depend which recited (as amended on March 11, 2003) that the aromatic source is a fluid cat cracker stream.

Claims 1 and 4 have been amended in the present amendment to bring them back into conformity with the language and teaching of the specification, namely, that the aromatic source is selected from the group consisting of reformate, a fluid cat cracker stream and mixtures thereof. This obviates the 35 U.S.C. § 112, second paragraph, rejection of claims 7-9 by reinserting the language they originally depended upon.

The Examiner rejects claims 1-9 under 35 U.S.C. § 102(b) as being anticipated by Tsuboi (USP 6,187,171) for the reasons of record. The Examiner maintained (in the

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Office Action of 12/19/02) that Tsuboi teaches a method for using reformat having 30% aromatics contents by volume in (un-) leaded gasoline for engines for controlling deposits or improving cleanliness in air intake system or combustion chamber "that include injectors". The Examiner concludes that this anticipates the instant claims.

Applicants must respectfully contest this rejection.

Tsuboi (USP 6,187,171) is directed to an unleaded high octane gasoline exhibiting reduced gun formation and improved air intake system and combustion chamber cleanliness. This fuel comprises at least one reformat produced by a continuous regeneration type reformer and/or at least one reformat fraction produced by a fixed bed type reformer.

As is clear, Tsuboi is directed to a gasoline made up of specific reformat streams derived from particular types of reforming processes, i.e., continuous regenerative reformers and fixed bed reformers. Tsuboi places special significance on the particular reformat described and is not directed to reformat in general. The reformat of Tsuboi meets particular characteristics defined by the formula:

$$Z = \left(\frac{1}{100} \right) \left[\sum (ax) + \left(\frac{1}{9} \right) \sum (by) \right] < 0.010$$

where Z, a, x and y are as defined in the patent.

This is not to say that reformat was not used in the past as a component of gasoline. Indeed, Tsuboi itself states at column 1, lines 14-17 of Background of the Invention, that:

"High-octane gasoline blending stocks produced by Fluid Catalytic cracking (FCC) units and catalytic reformers have been more

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extensively used for automobile gasoline, since introduction of regulations on use of leaded compounds, e.g., tetrethyl lead, as octane improvers."

Lines 23-25:

"Such high octane, unleaded gasoline contains large proportions of high-octane gasoline component stocks, e.g., those produced by FCC units and reformers, and toluene."

The invention of Tsuboi, however, is that whereas heavy aromatic hydrocarbons in gasoline have an effect on gum formation and cleanliness of air intake systems and combustion chamber deposits in gasoline engines, his fuel, marked by being a fuel of a continuous regenerative reformer reformat and/or a fixed bed reformer reformat meeting the characteristics requirement of:

$$Z = \left(\frac{1}{100} \right) \left[\Sigma (ax) + \left(\frac{1}{9} \right) \Sigma (by) \right] < 0.010$$

has been found to positively impact air intake system cleanliness and combustion chamber deposits. Tsuboi, therefor, is directed to a very specific reformat or reformat blend and is silent with respect to any particular feature or fraction of FCC streams.

The Examiner points out that Tsuboi addresses air intake systems and combustion chamber deposits. Tsuboi indicates in the "Background of the Invention" that when deposits are formed on air intake valves the deposits work as obstacles to the flow of gasoline out of the fuel injector device with the result that its operability is lowered (column 1, lines 50-54).

From this the Examiner apparently draws the conclusion that Tsuboi is clearing, or keeping clean, fuel injector devices.

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This is believed to be an incorrect conclusion.

As previously pointed out, the fuel injectors of the type embraced by Tsuboi's discussions are port fuel injectors which spray fuel into the area outside the cylinder for mixture outside the cylinder with air, the resulting air-fuel mixture being then drawn into the engine through the intake port past the intake valve during an engine piston down stroke. This type of fuel injector which is adversely affected by intake valve deposits is not the direct fuel injection addressed in the present invention.

Tsuboi is directed to reducing the fouling of the intake valves and a reduction in combustion chamber deposits.

It is not obvious that the control or reduction of intake valve deposits and combustion chamber deposits correlate with the control or reduction of deposits on gasoline direct injectors. Merely because IVD or CCD are controlled by a particular base fuel compositional profile or additive combination does not mean that the deposits on the tips of gasoline direct injectors would or could also be controlled. The control of deposits on gasoline direct injectors is not an obvious or expected result.

To repeat, the fuel injectors discussed by Tsuboi which are adversely effected by intake valve deposits generate the fuel spray outside the combustion chamber. They are adversely effected by deposit build-up on the intake valve.

Conversely, gasoline direct injectors generate the fuel spray directly in the combustion chamber. All that is taken in by the intake valve is air not an air-fuel mixture. The gasoline direct injector spray tip is inside the combustion chamber and subject to the temperature and pressure of the combustion chamber.

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In the Examples, Tsuboi generates a gasoline corresponding to his invention and two comparative examples. These three exemplified fuels are formulated from different reformat, alkylate, and FCC-naphtha streams described in detail in Table 1.

Reformat Fraction A1 corresponds to a reformat used to formulate gasolines outside the scope of Tsuboi's claims.

Reformat Fraction A1, has an initial boiling point (IBP) of 139°C, a T_{10} of 143°C, a T_{50} of 147°C, a T_{90} of 165°C, an End Point (EP) of 199°C and a RON of 117, and a C_{11+} aromatics hydrocarbon content of 0.35 vol%.

Reformat Fraction B, B₂ and B₃ correspond to reformat fractions used to formulate a gasoline that is within the scope of Tsuboi's claims.

Reformat Fraction B₁ has an IBP of 25°C, a T_{10} of 34°C, a T_{50} of 87°C, a T_{90} of 166°C, an End Point (EP) of 180°C and a RON of 95.5, and a content of aromatic hydrocarbons having a carbon number of 11 or more of 0.09 vol%.

Reformat Fraction B₂ has an IBP of 106°C, a T_{10} of 108°C, a T_{50} of 109°C, a T_{90} of 110°C, an End Point of 111°C and a RON of 120, and a content of aromatic hydrocarbon having a carbon number of 11 or more of 0.00 vol%.

Reformat Fraction B₃ has an IBP of 104°C, a T_{10} of 107°C, a T_{50} of 108°C, a T_{90} of 109°C, an End Point of 413°C and a RON of 108, and a content of aromatic hydrocarbons having a carbon number of 11 or more of 0.00 vol%.

By comparison, in the specification of the present application a reformat suitable for use in the present application is one characterized by having an IBP of between about 90-95°F (about 32°C to 35°C), a T_{10} of between about 140-145°F

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(about 60°C to 63°C), a T_{40} of between about 310-320°F (about 154°C to 160°C), an End Point of between about 400-430°F (about 204°C to 221°C), and a RON of about 95 to 105, (see page 6).

As is clear, the reformat described in the present specification is a very wide boiling product, the characteristics of which broadly overlap those of all four reformates recited in Tsuboi, especially in the end point which exceeds the End Point of Reformat B_1 by from about 24°C to 41°C, the end point of Reformat B_3 by from about 16°C to 33°C, and the End Point of Reformat A, by from about 5°C to about 22°C, indicating the presence of a substantial high boiling (heavy) component. Whereas Fraction B_1 already has a content of aromatic hydrocarbons having 11 or more carbons of 0.09 vol%, the reformat described in the present specification containing a substantial fraction of even heavier boiling material would be believed to necessarily contain a higher vol% of aromatic hydrocarbons containing 11 or more carbons. Indeed, fuels Aro-1, Aro-2 and Aro-3 exemplified in the present application all utilize a 98 RON reformat from a fixed bed reformer. The reformat contained 3.32% C_{11}^+ aromatics as part of the whole reformat. As shown in the forthcoming Declaration of the Inventor Noyes L. Avery, using the formula for calculation of the Tsuboi Z factor, Aro-1 and Aro-3 had Z values of 0.0553 while Aro-2 had a Z value of 0.202, all well in excess of Tsuboi's limit of Z being less than or equal to 0.010.

The use of such a fraction as such or in too high a concentration so as to make the resulting Z value of Tsuboi exceed 0.01 would clearly be outside the teaching of Tsuboi.

In the comparative examples, even substantial portions of light FCC stock (50% and 45% respectively for comparative examples 1 and 2) did not result in a fuel demonstrating a significant reduction in IVD or CCD in the cases where the Tsuboi Z values exceed 0.01 which would have led one to discount the ability of such fuels to

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control (reduce or eliminate) deposit formation in general. That being the case there would have been no reason at all to ever suggest that fuels similar to those of the comparative examples would or could control deposit formation on gasoline direct injectors.

Tsuboi therefor does not address gasoline direct injectors and does not teach, suggest or imply that gasoline direct injectors can be cleaned or kept clean by using a gasoline fuel containing aromatics the source of which is reformat in general or fluid cat cracker stream material wherein 70-100% of the fluid cat cracker stream material is light fluid cat cracker stream material, or mixtures of such reformat and FCC material.

The result obtained in the case of gasoline direct injectors using such fuel, that is, a reduction in deposits on such gasoline direct injectors, is not taught or practiced in Tsuboi; therefore, Tsuboi does not anticipate the present invention, nor does Tsuboi suggest such a result meaning that Tsuboi does not render the present invention obvious.

While the Examiner is correct in the Action of 6/11/03 in pointing out that Tsuboi teaches a FCC naphtha and in Table 3 identifies that product (by listing of boiling profile) as a light FCC, it must be recognized that in Comparative Examples 1 and 2 which contain 50% and 45% respectively of such FCC material, the IVD and CCD levels were elevated as compared to Tsuboi's Inventive Example, and as was previously indicated the performance of a fuel with respect to IVD and CCD (be it beneficial or detrimental) is not a sure basis for attempting to predict the behavior of that fuel in respect to deposit control on gasoline direct injectors.

The Examiner rejects the claims under 35 U.S.C. § 103(a) as unpatentable over Orr (WO 87/01384) in view of Russell et al (USP 5,518,511) and Molfer et al (EP 0 647 700) for the reasons of record in the December 19, 2002 Office Action.

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In that action the Examiner states that applicants make an admission in the preamble of claim 4 that fuels comprising gasoline having a T₉₀ range of about 150-182°C, about 36 to 20 vol% olefins, about 5-400 ppm sulfur and about 10-45 vol% aromatics are combusted in gasoline engines.

This is true so far as it goes to this point.

The Examiner then states that applicants make an admission on the record for a method for controlling the formation of injector tip deposits in a gasoline direct injector and the improvement is the use of aromatics selected from reformat, FCC and mixtures thereof.

Applicants must disagree with the Examiner's characterization of the above as an "admission".

The statement is not an admission but a recitation of applicants' discovery. The statement that the aromatics are secured from reformat, FCC stream or mixtures thereof, wherein the FCC stream comprises 70% to 100% light FCC stream follows the term "the improvement comprising".

In Jepson type claims, the section following the phrase "the improvement comprising" is not an admission of prior art but a statement of what is considered to be the applicants' invention over the prior art. Thus, the basis for the Examiner's comment about an "admission" in the current context is not understood.

The Examiner cited Orr in the Action of December 19, 2002 as teaching reformat derived aromatics content up to 45% by volume in unleaded gasoline to

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improve RVP that would result in improved air intake system or combustion chamber (deposits?), that include injectors.

Orr, WO 87/01384 teaches a fuel composition comprising a defined proportion of cyclopentadienyl manganese tricarbonyl anti-knock additive, C₁-C₆ aliphatic alcohol solvent, aromatic hydrocarbons and unleaded base gasoline to alleviate and correct long term hydrocarbon combustion emissions technical enleanment characteristics, increased RVP, initial and mid-point distillation depression, high end boiling point temperatures and resultant increases in emissions (page 12, lines 19-29).

The text at page 17, lines 15-29, goes into aromatic content, indicating that up to 45% aromatics is an acceptable range, while 1 to 20 vol% is desirable. The aromatic boil in the range up to about 700°F, preferably 200°F to 550°F. It is not stated what the source of these aromatics is.

At page 21 it is indicated that the aromatics are the products of reformers, fluid catalytic crackers, riser cracker units or coker units using naphtha, gas oil, resid, coal liquids, shale oils, asphalt and/or other stocks.

At page 22 it is indicated that aromatic hydrocarbons are not included in gasoline because of the expense to do so or because of increased exhaust emissions (lines 9-22).

Orr's invention is the discovery that through the use of MMT (cycloaliphatic manganese tricarbonyls), C₁ to C₆ alcohols, aromatic hydrocarbons and, if necessary, cosolvents together with normal boiling range gasoline there is a reduction in emissions and end boiling point of the fuel composition and an improvement in RVP and distillation characterization of the fuel (page 22, lines 23-31).

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Careful review of the text associated with what Orr considers the invention which begins at page 11 failed to locate any reference to the control or reduction of intake valve deposits, combustion chamber deposits or deposits of any kind on any type of fuel injectors. Orr directs his invention to finding a way to introduce MMT anti-knock additives into gasoline to make them acceptable to the EPA, and to formulating a gasoline containing MMT, C₁-C₆ alcohol, aromatics (in general) and base gasoline which exhibit reduced emissions and improvements in RVP and distillation end point. Gum formation is discussed at pages 26-27, but is addressed by the use of antioxidants or antigumming agents.

At page 30, lines 30-36, it is stated that the invention also contemplates the use of other additives such as gum and corrosion inhibitors, multipurpose additives and scavengers, made necessary or desirable to maintain fuel system cleanliness and control exhaust emissions due to the presence of alcohol, organo-manganese compounds and aromatic hydrocarbons in the fuel.

Fuel injection systems are mentioned at page 8 as part of the Description of the Prior Art, in the context of the use of methanol or other alcohols in gasoline. Because fuel injection systems and carburetors are adjusted to provide a predetermined stoichiometric ratio of air to fuel and hence of oxygen to fuel, addition of alcohol to the gasoline tends to upset this balance in vehicles that are not equipped with oxygen sensing devices. Higher oxygen to fuels ratios contribute to environmentally harmful NO_x emissions.

Clearly, Orr does not teach, suggest or imply any control or reduction of deposits of any kind. He makes no mention of intake valve deposits or combustion chamber deposits nor does he make any reference at all to injectors of any kind.

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Nothing in Orr can be interpreted as teaching, suggesting or implying that the deposit formation on gasoline direct injectors can be controlled or reduced by using as the fuel a gasoline containing aromatics wherein the aromatics source is selected from the group consisting of reformat in general, FCC, mixture thereof, wherein a light FCC constitutes from 70% to 100% of the FCC.

Applicants cannot agree that Orr teaches the present invention simply because Orr describes a gasoline that can be combusted in an engine.

Applicants cannot accept and do not agree with the Examiner's statement that it would be reasonable to combust the fuel of Orr with an engine and that it would be reasonable to expect to control or reduce deposit formation on the injectors of gasoline direct injector engines because the fuel comprises the aromatic content as that of the instant claims.

Nothing in Orr is directed to deposit control of any type. It is not clear at all nor suggested by Orr that his fuels either can or will control deposits. All Orr teaches is a gasoline for emissions control.

Even if Orr did disclose the particular gasoline possessing the presently recited aromatics concentration and source type, which is not hereby acknowledged in any way, there is nothing which would lead one to conclude that such a fuel would or could be used in a process to reduce or control gasoline direct injector deposits or that such a fuel should be selected to effect such a control.

The Examiner's statement is an attempt to rely on the present applicants' own teaching as a basis for rejecting applicants' claims.

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It must be emphasized at this point so that one does not lose sight of the fact that the claims of the present invention are directed to a method for controlling the deposits on gasoline direct injector. The claims are not directed to a fuel per se as a composition of matter.

The Examiner relies on Russell (USP 5,518,511) and Malfer (EP 0 647 700) as teaching that the compositions of the gasoline have a direct effect for preventing or reducing deposit formation in the fuel injection systems of spark ignition internal combustion engines including the inlet (intake) valves and injector system.

Applicants traverse the Examiner's use and reliance on these references.

Russell et al teaches a multi-functional gasoline detergent composition leading to reduced engine deposits, little or no value stick and without effect on Octane Requirement Increase. The composition contains a polyisobutenyl succinimide detergent, a mono end capped polypropylene glycol as carrier oil and a hydrocarbon solvent.

The patent in its discussion of the prior art indicates that among the criteria which must be met by multi-functional detergent containing additive compositions for gasoline are elimination of carburetor and injector fouling, good detergency in the intake port and intake valve regions of the engine, elimination of valve stick, corrosion protection, good demulsifying characteristics, and little or no effect on the Octane Requirements Increase (ORI) of modern engines.

It must be noted that this elimination of carburetor and injector fouling is associated with the performance criteria of the multi functional detergent used in a gasoline and not with any particular hydrocarbon compositional characteristics of the gasoline per se.

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According to the patent, at column 6, "gasoline" refers to motor fuels meeting ASTM Standard D-439 and includes blends of distillate hydrocarbon fuels with oxygenate fuels such as ethanol, as well as the distillate fuels themselves. The fuels may be leaded or unleaded and may contain other conventional additives including scavengers, anti-ring additives, octane improvers, etc., in addition to the particular additive combustion of the Russell patent itself.

In the Examples the only reference made to the base gasoline itself is that a CEC legislative reference premium unleaded gasoline, coded RF-08-A-85 was used.

In Table 4 a boiling point and total saturates, aromatics, and olefins profile for unleaded gasoline is presented but the source, nature, and particular types of saturates, aromatic, and olefins are not reported or otherwise discernable. The patent is silent as to the particular hydrocarbon compositional make-up of the fuel per se. Thus, while the patent may recite an aromatics content of 40.6% for unleaded gasoline, just what type of aromatics they are is not known, nor is their source known or suggested.

Thus, when the patent refers to a reduction in intake port and intake valve deposits, such reductions are attributable to the additives employed, and not to the hydrocarbon compositional make-up of the base gasoline. Finally, the patent itself contains no examples directed to injectors or injector fouling, the only language referring to injectors being found in both the description of the Prior Art and in the Object of the Invention, in both cases, the elimination of injection fouling being a desirable characteristic of a multifunctional detergent composition. The patent does not teach, suggest or imply that injection fouling of any kind, be it fouling of the common port fuel injectors which direct their spray into a space outside the combustion chamber or the fouling of gasoline direct injectors which direct their spray directly into the

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combustion chamber, is or can be controlled to any extent whatsoever by manipulation of the hydrocarbon compositional make-up of the gasoline itself.

Malfer et al teaches a fuel additive composition for the control of intake valve deposits. The additive comprises a gasoline soluble Mannich reaction product and a gasoline soluble poly(oxyalkylene) compound.

This reference is particularly directed to intake valve deposits and the control which can be exerted over such deposits by the selection of a unique detergent composition.

At page 6, lines 9-11, the reference indicates that it is preferred that the fuel compositions of this invention include other conventional additives such as antioxidants, demulsifiers, corrosion inhibitors, aromatic solvents, etc.

At page 7, lines 14-17, the aromatic solvents are described and include benzene and alkyl substituted benzene or mixtures thereof or mixtures of other aromatic solvents many also be used. This is the extent of the description of such aromatic solvents.

In describing the fuels in which the additive can be used, the reference indicates that it is a hydrocarbon mixture in the gasoline boiling range or hydrocarbon/oxygenates mixture, or oxygenates, middle distillate fuels, notably, diesel fuels and fuels for gas turbine engine. "The nature of such fuels is so well known to those skilled in the art as to require no further comment", page 7, lines 31-32.

The essence of Malfer, et al. is the particular additive combination, used in a sufficient amount to reduce or inhibit deposit formation on intake valves, but deposits on fuel injectors may also be reduced or at least controlled. This possible reduction or

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control of fuel injector deposits, however, is not being attributed to the fuel per se but to the Malfer et al additives present in the fuel.

In the reference example the control of intake valve deposits is addressed. It is stated at line 17 of page 8 that "Before each test was begun, the intake manifold and cylinder head were cleaned and inspected, the fuel injectors were checked for proper flow and spray pattern. Following each cleaning and inspection the engine was rebuilt with new intake valves and the crankcase oil was changed".

In the Examples the effect on intake valve deposits and combustion chamber deposits were evaluated.

Referring back to an earlier discussion in this communication, intake valve deposits are a phenomenon which builds up on intake valves and around intake valve seals in engines equipped with port fuel injectors which direct their fuel spray into an area outside the cylinder to create an air-fuel mixture outside the cylinder which mixture is then drawn into the cylinder through the intake port/around the intake valve by the downstroke of a piston in the cylinder. These injectors are not inside the cylinder but external to the cylinder.

Further, any control of deposits or cleaning of the intake valve is attributed to the Malfer et al additive package and not to the hydrocarbon composition profile of the gasoline used. In the Examples there is no mention of any cleaning of injectors nor that there was any cleaning of the injectors which were located outside the cylinders.

Clearly, no benefit or positive influence is attributed to the hydrocarbon composition profile of the base fuel.

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By comparison, the injectors which are kept clean or cleaned in the process of the present invention are gasoline direct fuel injectors mounted in the cylinder not outside the cylinder, and these gasoline diesel fuel injectors are cleaned or kept clean by or have their deposits reduced by use of a gasoline fuel containing aromatics wherein the aromatics are not just any aromatics which may be or can be in gasoline, but rather those aromatics which are attributable to the presence of reformate in general, fluid cut cracker stream product, mixture of reformate and fluid cut cracker stream product wherein the FCC stream is 70-100% light FCC stream in the gasoline.

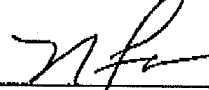
This is not taught, suggested or implied by any reference individually or by any combination of references cited by the Examiner.

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It is requested that the Examiner reconsider this case in light of the amendment made to the claims, which are believed to put the case into condition for allowance or at least in better condition for appeal, the accompanying remarks, that she withdraw the rejection, allow the claims and pass the case to issue in due course.

Respectfully submitted,



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☒ Pursuant to 37 CFR 1.34(a)

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